THE EFFECT ON THE JEJUNAL MUCOSA OF EXPOSURE TO
THE GASTRIC JUICE.*

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The investigation was made for the purpose of observing the continued effect of gastric juice on an isolated portion of the jejunal mucosa. It was thought that by concentrating the effect it would be possible to determine the part played by the gastric juice in the production of gastro-jejunal ulcers.

The operative procedure consisted in functionally resecting a loop of the first part of the jejunum, varying in length from six to twelve centimeters, and implanting it with intact blood supply into the posterior wall of the stomach, in the region of the antrum of the pylorus. The continuity of the intestine was maintained by anastomosis. In some of the experiments silk or linen sutures only were used, in others catgut was used for the through and through sutures. All the operations were done under ether anesthesia. In this manner the portion of the jejunum, which is usually next to the stoma in a gastrojejunostomy, was placed in the part of the stomach which is almost always bathed with free acid. Furthermore, the condition of the transposed jejunal mucosa differed from that of the mucosa near the stoma of a gastrojejunostomy, in that the former was not protected by the other intestinal secretions. Because of this, the effect of the acid should have been many times greater on the transposed jejunum.

Dogs operated on in this manner recovered from the operation and maintained excellent health for many months. At various periods thereafter the animals were killed, and after the gross specimens were studied, sections of the transposed jejunum, and of the jejunum near the origin of the former, were fixed in various solutions for microscopic examination.

The work of previous investigators has touched on certain

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phases of this problem. Soresi,¹ in a study of plastic operations on the gastro-intestinal tract, found that the small intestine could be used as a patch to repair defects in the stomach. His work dealt only with the operative phases. Smith² transposed or transplanted portions of many of the viscera in order to determine whether metaplasia took place, but the transposition of the jejunum into the stomach was not included in his operations. He transplanted the gall bladder, the urinary bladder, and the uterus successively into each other and into the peritoneum. A transplantation of the ureter into the gall bladder and uterus was also done. From the results of a large series of experiments he found that the epithelial surface of the implanted organ underwent a change in structure. This change occurred when the epithelium of one organ differed in type from that of the other, and was the result of replacement of the epithelium of the implanted tissue by another derived from the receiving organ. The replacement of epithelium depended on the environmental condition. It did not occur in a neutral environment, such as the peritoneal cavity. He found that the implantation of the gall bladder into different viscera, such as the large and small intestines, produced an active proliferation of gall-bladder cells, a rearrangement of the crypts, and an early active infiltration of the sub-epithelial tissue. When transplanted into the stomach there was a marked hypertrophy of the gall-bladder mucosa. Implantation into the large or small intestine of flaps of gastric mucous membrane caused a disappearance of the chief and parietal cells and the development of a different type of cell, which resembled a mucus-forming cell of the pylorus.

Harvey³ studied the changes taking place in the gastric mucosa at the site of the stoma of a gastroduodenostomy and after pyloric obstruction. He did not study the changes occurring on the duodenal side of the stoma. The changes in the gastric mucosa took place within seven millimeters of the suture line. They consisted in a gradual transformation of the body chief cells into mucus-forming cells. This process reached its maximum about three weeks after the operation. After one month a reverse transformation began and

the same cells became ferment cells. The process was completed six and one-half months after operation. Cells were found containing both mucus and zymogen.

The results of the investigation here reported are based on fourteen experiments. The specimens were obtained after operation as follows: 2 days, 6 days, 13 days, 22 days, 22 days, 51 days, 83 days, 90 days, 112 days, 146 days, 173 days, 282 days, 291 days, and 330 days.

When the dogs were killed within a week after operation, the specimens grossly presented swelling and edema at the suture line which are noted in all recent operations on the gastro-intestinal tract. Away from the suture line the jejunum did not show any changes. The specimens obtained after complete healing had occurred showed a few gross changes. These increased progressively to a maximum a few months after operation, and consisted of (1) a slight increase in the thickness of both mucosa and muscularis, (2) a throwing of the mucosa into folds which corresponded roughly to the rugæ, and (3) a change in the color of the mucosa, which became much lighter and was covered with a thick mucoid substance (Fig. 1).

While the increase in the thickness was definite, it was not very marked or constant. The earliest specimens obtained after operation in which an increase in thickness was noted was fifty-one days. In four specimens showing the most marked increase in thickness, measurements of the transposed tissue and normal jejunum were compared. The average total increase in thickness of the transposed jejunum was .65 millimeter; the muscularis had increased an average of .35 millimeter, and the mucosa .3 millimeter.

The microscopic picture varied considerably in the different specimens. This variation was not due wholly to difference in time after operation because specimens obtained at approximately the same time after transposition did not present a uniform appearance. In a few experiments there was an increase in the mucus-producing cells. In some cases these were increased not only in number, but also in

size. Some tubules seemed to be composed almost wholly of goblet cells. In a few of the specimens there was a very active cell proliferation. This appeared to be an exaggeration of the normal cell division occurring in the base of the glands. In some instances there was a decrease, and in a few areas almost total absence of gland cells. In these specimens there might also be an infiltration of the sub-epithelial tissue. The latter changes may have been due to the changes of environment or to a decrease in the blood supply. In general, the changes were slight and in many cases it was impossible to distinguish between sections of the transposed jejunum and sections from the jejunum at its site of origin.

If the gastric juice is a primary factor in the cause of gastro-jejunal ulcers, an isolated jejunal mucosa exposed almost continually to the gastric juice should show a large percentage of ulcers. This was not the case in our series of experiments. Only one specimen of the animals operated on showed ulceration. This was a hard indurated ulcer near the pyloric end of the transposed mucosa and examination showed that it had formed around a retained linen suture (Fig. 2). This is in accord with the clinical experience of W. J. Mayo,⁴ and the experimental results of Soresi,⁵ in regard to ulceration at the stoma of a gastro-jejunostomy. The results of these experiments seem to indicate that the gastric juice does not play a primary part in the formation of gastro-jejunal ulcers.

Since the microscopic examination showed that the transposed mucosa for the most part remained anatomically normal, it was desirable to know whether it was also physiologically normal. It was possible to use only one functional test. This consisted in estimating comparatively the power of the transposed mucosa to absorb fat. In two instances the animals were given a meal rich in fat and after 90 and 135 minutes respectively they were quickly killed. The respective lengths of time after operation were 282 and 291 days. A comparison was made of the fat found in the cells of the transposed mucosa and the upper jejunal mucosa. Some

of the sections were fixed in osmic acid; others in formalin and stained with Sudan III. The results showed that the power of the transposed mucosa to absorb fat was but slightly diminished. In many areas the transposed mucosa showed as large an amount of fat in the cells as the normal mucosa. Fat was not found uniformly throughout the transposed mucosa. In some areas it was almost absent. In these places the cells appeared to be mainly goblet cells. As regards fat absorption, the transposed mucosa was almost normal.

If more time had been allowed it is possible that greater changes, both anatomical and physiological, might have been observed. However, the fact that some of the specimens which were secured the longest time after operation showed very little change validates this possibility. I believe that the changes which consisted of a loss of gland cells and sub-epithelial infiltration were due to a decrease in the blood supply. After a while a collateral circulation from the wall of the stomach was established, but the capacity of this was not very great, as shown by the injection of aqueous eosin solution. The constant stretching of the branch of the mesenteric artery supplying the transposed jejunum decreases its capacity, so that the blood supply must be diminished.

SUMMARY.

When an isolated portion of the jejunum is transposed into the wall of the stomach the following changes may be noted: There may be slight thickening of both mucosa and muscularis. The mucus-producing cells may be increased in both number and size. There may be an active cell proliferation. In several of the experiments no change in the transposed mucosa was noticed. Ulceration of the mucosa occurred in one experiment, and in this case a more absorbable suture was found in the base of the ulcer. The gastric juice is probably not the primary cause of gastro-jejunal ulcer. The function of the transplant as tested by its power to absorb fat was practically normal.

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DESCRIPTION OF PLATE XXII.

FIG. 1. — Photograph of transposed jejunum 200 days after operation. Note the folds of jejunal mucosa and the small pockets at each end where the jejunum was folded.

FIG. 2. — Photograph of transposed jejunum 173 days after operation. The large indurated ulcer at the upper angle has a non-absorbable suture at its base.

FIG. 3. — Photomicrograph of specimen of transposed jejunum obtained 281 days after operation. The animal had been given olive oil 90 minutes before being killed. The mucosa was fixed in acetic-osmic-bichromate and stained with hemotoxylin. Note that the tubules are perfectly normal. There is considerable fat in the cells at the upper part of tubule. Magnification 160.

FIG. 4. — Photomicrograph of another tubule from same specimen as Fig. 3, showing fat absorption. Magnification 220.

FIG. 5. — Photomicrograph of higher magnification (x 320) of same specimen as shown in Figs. 3 and 4. The cells are normal and capable of absorbing fat.

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